Functional properties of stored grains after microwave treatment

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Abstract

Insect infestation is the major cause of losses in many stored products such as grains, seeds, cereals and legumes. Certain insects can exist under a wide range of conditions and can attack products at all phases of storage and distribution.

The use of chemicals to control insect infestation has been widely applied and is now cause for concern over its hazardous effects. Alternative means should be explored and one such possible method is the use of microwave heating. However, microwave radiation may affect the functional properties of the products. The main objective of this paper is to evaluate the effects of microwave treatment on the functional properties such as gelatinisation, water and oil absorption capacity, foaming capacity and stability of stored rice, glutinous rice, groundnut and mungbean.

It was observed that gelatinisation property was improved by microwave treatment, but, lipids in groundnut inhibited gelatinisation of its starch. Foaming capacity decreased significantly with increasing of microwave exposure time, while water and oil absorption capacity were increased in these products.

Introduction

It was reported in 1991 that more than 30% of agricultural products in Malaysia were destroyed by insect infestation. In addition, insects also contribute a major sanitation and quality control problem by contaminating the stored food products with their fragments, faeces, webbing and a variety of microflora (Zain 1991). Thus, control measures are important to overcome these problems.

Chemical treatment using insecticides and other biological methods are commonly used to control insect infestation in stored products. The use of chemicals to control insect infestation has been widely applied and is now causing concern because of hazardous effects. Alternative means which may be used to replace existing insect control practices should be explored and one such possible method is the use of microwave heating.

Microwave heating offers some advantages over the conventional use of chemical insecticides. These advantages are: the absence of toxic residues, destruction of all stages of insect infestation and a short microwave exposure time of a few seconds. Microwave radiation, however, may affect the functional properties of the stored products for their application and utilisation in the food system. Consequently, this has to be considered in the application of microwave energy in controlling insect infestation in stored cereals and legumes.

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Cereals such as rice and glutinous rice are rich in carbohydrates, while legumes such as peanuts and mung beans are rich in proteins. Functional properties are largely determined by the components of starch and protein (Fennema 1985; Luallen 1985); and they affect the physical behaviour of food as well as the sensory characteristics such as the texture. The main objective of this paper is to evaluate the effects of microwave treatment on the functional properties of stored rice, glutinous rice, peanuts and mung beans.

Materials and Methods

Four commercial dry cereals and legumes namely rice (*Oryzae sativa* L. cultivar *indica*), glutinous rice (*Oryzae sativa* L. cultivar *japonica*), peanuts (*Arachis hypogala* L.) and mungbean (*Vigna radiata* L.) were purchased from a local market and cleaned.

A 240 V, 6.0 A microwave oven (Genins, model NN–9850) producing 750 W output power, operating on a frequency of 2450 MHz using a magnetron oscillator and of 0.042m^3 capacity was used.

Samples weighing 250 g were heated in the microwave oven for exposure times of 0 (control), 10, 20, 30, 40, 50 and 60 seconds.

Samples were ground and screened to obtain 30 mesh flour before analyses of functional properties were carried out.

Water and oil absorption capacity were determined according to the method of Beuchat (1977) with slight modifications. A 1 g sample was mixed with 10 mL distilled water or maize oil (Vecorn, 100% pure maize oil) in a 15 mL centrifuge tube. The sample was then vortexed for 1 minute, allowed to stand at room temperature (29°C) for 30 minutes then centrifuged at 2000*g* for 30 minutes. The volume of supernatant was noted in 15 mL graduated cylinder. Density of water was assumed to be 1 mL/g and oil was determined to be 0.88 mL/g. Results were expressed as g/g of sample on a dry weight basis.

A Brabender Viscoamylograph type, D–4100 Duisburg 1, equiped with a 700 cm.g carfridge was used to study the flour gelatinisation. AACC method 22–10 (AACC 1980) was followed with slight modifications.

Results and Discussions

Water and oil absorption capacity

It was observed that microwave heating considerably increased both the water and oil absorption capacity of rice, glutinous rice, peanuts and mung beans. This may be due to the dissociation of proteins that occurred during heating, and these dissociated subunits having more water binding sites than the oligomeric proteins (Rahman and Mostafa 1988). Similar increases in water and oil absorption capacity were reported on blanched mung-bean flour (Rasario and Flores 1988).

Increase in oil absorption could also be due to the denaturation of protein by heat, which might unmask the nonpolar

residues from the interior of the protein molecules, as reported by Abbey and Ibeh (1987).

Figure 1 shows the effect of microwave heating on water absorption capacity of the four samples, while Figure 2 shows the effect of microwave heating on oil absorption capacity. The results show that mungbeans had the most water and oil absorption capacity followed by peanuts, glutinous rice and rice. The oil absorption capacity for peanuts was low because of its high lipid content, which results in less available space for oil binding. It may be concluded that mungbeans had higher water and oil absorption capacity than rice and glutinous rice due to their higher protein content. However, the increase was not significant at $p = 0.05$, probably due to the short microwave heating time.

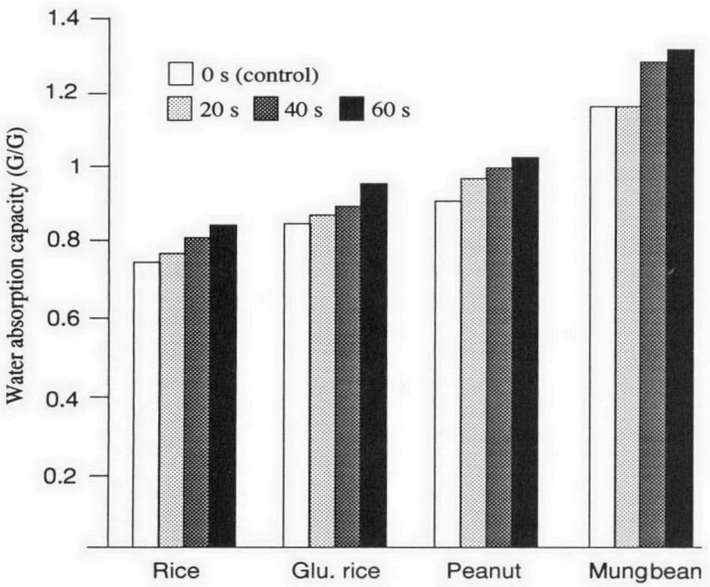

Fig. 1. Effect of microwave heating on water absorption capacity of rice, glutinous rice, peanuts and mung beans.

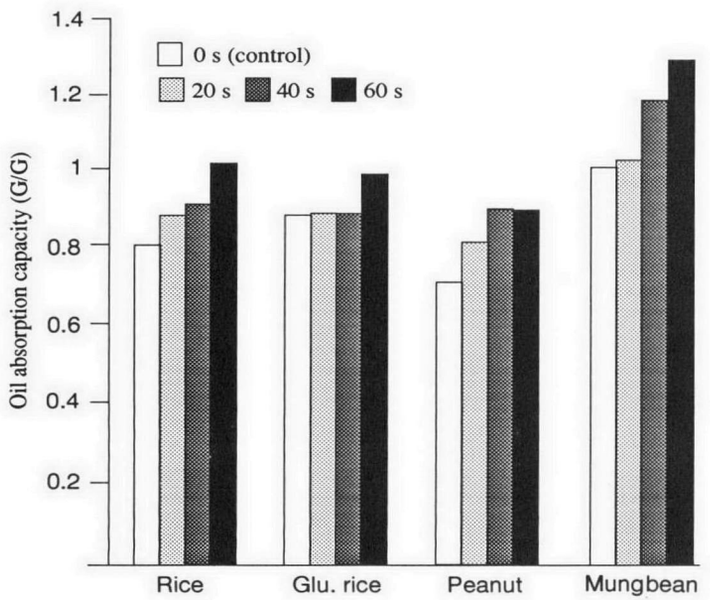

Fig. 2. Effect of microwave heating on oil absorption capacity of rice, glutinous rice, peanuts and mung beans.

Gelatinisation

It was observed that gelatinisation was improved by microwave treatment since paste viscosity increase and gelatinisation temperature were lowered. Microwave heating seemed to significantly ($p = 0.05$) increase the paste viscosity of glutinous rice, as shown in Figure 3. Rice had higher paste viscosity at longer microwave exposure times (Figure 4), while mungbean had a lower hot paste viscosity and a higher cold viscosity with increasing exposure time, as shown in Figure 5.

Roberts (1977) also demonstrated that rice at 30–35% moisture content showed promising gelatinisation results with microwave heating.

Peanut exhibited the worst gelatinisation properties due to the presence of lipid (Figure 6). Lipid actively inhibited swelling and gelatinisation of starch, as demonstrated by Tester and Morrison (1990).

Changes of gelatinisation property during 2 months of storage were not clear, probably due to the short storage time. This agreed with the work of Barber (1972), who reported that the gelatinisation temperature of milled rice remained unchanged after a long storage time, but that the paste viscosity increased. Increase in the paste viscosity could be due to the increase of free fatty acids during storage (Yasumatsu et al. 1964).

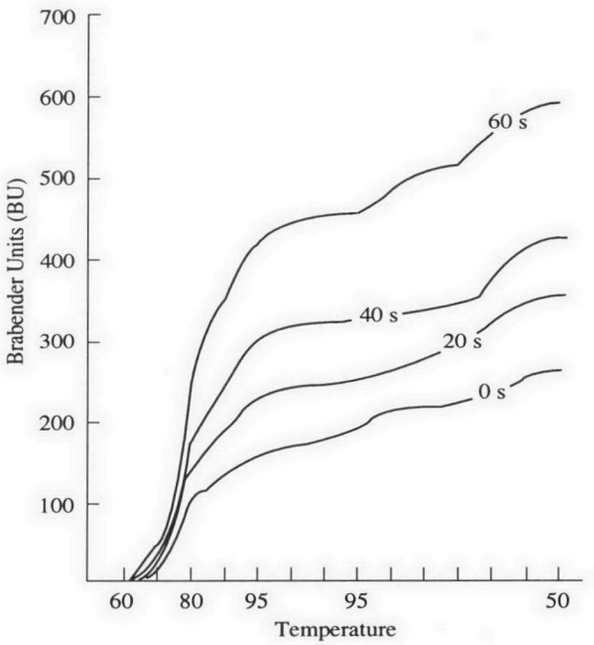

Fig. 3. Effect of microwave heating on gelatinisation property of glutinous rice.

Conclusion

Microwave heating may be used as an alternative method to control insect infestation in stored products. During 2 months storage of microwave-treated samples of rice, glutinous rice, peanuts and mungbeans their functional properties remained unchanged. Microwave heating was found to increase the water and oil absorption capacity but not significantly at $p = 0.05$. Mungbeans and peanuts which contained high amounts of protein exhibited good water and oil absorption capacity, while rice and glutinous rice, which contain high amounts of starch, showed better gelatinisation properties.

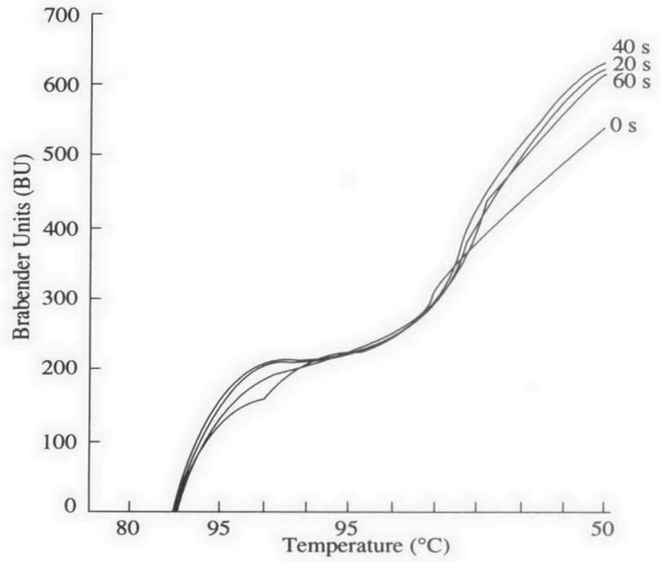

Fig. 4. Effect of microwave heating on gelatinisation property of rice.

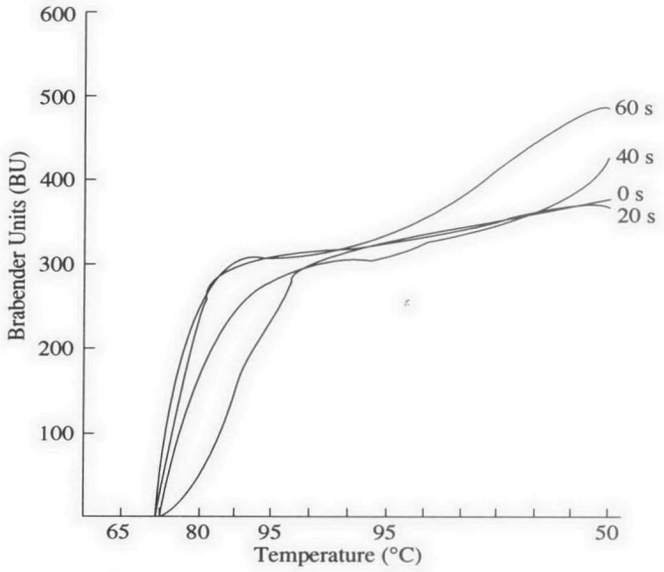

Fig. 5. Effect of microwave heating on gelatinisation property of mung bean.

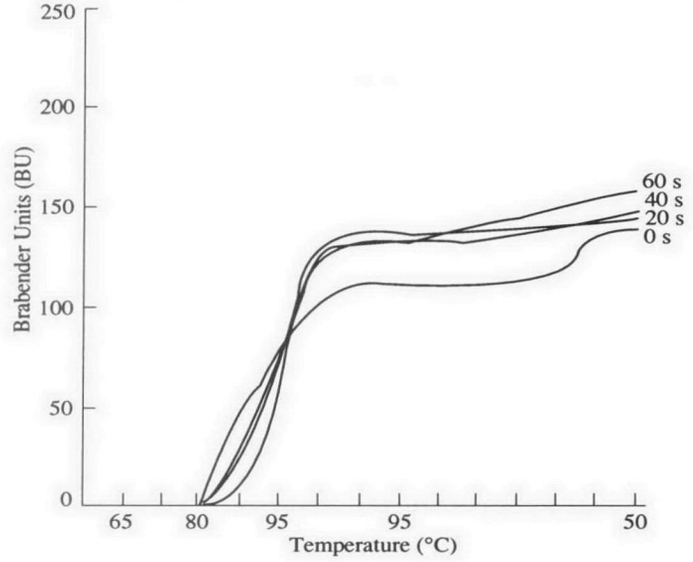

Fig. 6. Effect of microwave heating on gelatinisation property of peanuts.

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